

RF Structure Factory

•FNAL Structure Group's goals for the RF Structure R&D Factory:

- RF Design
- RF Structure Fabrication & Quality Assurance
- Infrastructure Setup for all above
- Major Infrastructure of the Factory are:
 - Two Clean Rooms, RF QC Area, Work Area
 - Two Vacuum Furnaces inside a soft sided Class 1000 Clean Room
 - Clean Room Leak Detector, Clean Room Pumping Station, RGA, Anaerobic Chambers, etc.



RF QC Clean Room, Class 3000



Assembly Clean Room, Class 1000



Vacuum Furnaces inside a Clean Room



Large Furnace Hotzone



Small Furnace



Residual Gas Analyzer (RGA)

FXA Type RF Structures

-We have produced three 20-cm long traveling wave structures: FXA-001, FXA-002 and FXA-003

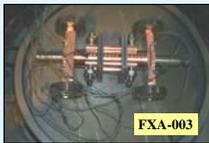


- Design is identical to SLAC T20VG5 structure (except brazing grooves in the disks)
- All brazed structures, no diffusion bonding
- Disks are precision machined, no diamond turning
- Couplers are precision machined with some diamond turned RF surfaces (iris area)

-FXA-001 was brazed at an outside furnace company

-FXA-002 couplers were brazed in Fermilab Small vacuum furnace and the rest of the brazing was done at an outside company

-FXA-003 was totally brazed and fabricated in Fermilab vacuum furnaces



FXA-003

These structures were not high power tested. They were produced to evaluate the feasibility of the Factory Infrastructure and to learn & gain experience in RF structure fabrication

FXB Type RF Structures

-We have produced six 60-cm long (full length) traveling wave, detuned, constant gradient structures: FXB-002 thru FXB-007

- Five of the six structures (FXB-002, -003, -004, -006 and -007) have undergone high power testing at NLCTA
- FXB production concluded with the completion of FXB-007
- FXB-006 achieved TRC R1 design requirement with 0.1 breakdowns in 1 hr. at 65 MV/meter gradient
- We have produced 9 full length dummy (no iris) structures for girder studies and brazing / fixture tests
- Design is identical to SLAC H60VG3 structure (except brazing grooves in the disks)
- All brazed structures, no diffusion bonding
- Disks & Couplers are precision machined, no diamond turning (industrial vendors)
- Brazing in vacuum furnaces, no hydrogen
- Fermilab designed couplers: fat-lipped & waveguide
- Traveler development (it is currently fully implemented & controlled)

Production History:

- FXB-001:** Damaged during construction. Became one of our "dummy" structures.
- FXB-002:** All-brazed structure assembled using a vacuum furnace at Advanced Thermal Processing (ATP). Fermilab design "fat-lipped" I/O couplers used.
- FXB-003:** All-brazed structure assembled at Fermilab but subsequently processed with 100% hydrogen at 1-Torr partial pressure in a vacuum furnace at ATP. Fermilab design "fat-lipped" I/O couplers used.
- FXB-004:** All-brazed structure in vacuum furnaces at Fermilab. Fermilab design waveguide (FWG) I/O couplers used.
- FXB-005:** Same as FXB-004, but disk pre-tuning prior to assembly resulted in problem: not sent to SLAC for high power testing.
- FXB-006:** Same as FXB-004 but disks were vacuum-fired at 1000 C for one hour prior to stack assembly & assembled structure was vacuum baked at 500 C for 72 hours. Achieved the NLC TRC R1 breakdown rate design requirement.
- FXB-007:** Identical to FXB-006. Currently undergoing high power test at NLCTA



FXB-002

FXC Type RF Structures

-Produced five 60-cm long traveling wave FXC RF structures: FXC-001 to FXC-005

- These structures are being used for Phase 2 of the Eight-Pack test at SLAC
- Design is identical to SLAC H60VG3S17 structure (except brazing grooves in the disks): 60 cm. long, 61 mm o.d. cells; 150 degree phase advance; 3% group velocity; slotted cells with .17 a/lambda
- All brazed structures (w/o hydrogen), no diffusion bonding. New brazing features were added to the disks
- Disks & Couplers are precision machined, no diamond turning (industrial vendors)
- Fermilab design FWG couplers and matching disks.

From FXB to FXC structures:

- HOM holes and keyhole slots were introduced to the RF disks; no HOM extraction
- Fermilab design waveguide (FWG) couplers and matching disks
- Tuning holes were increased from 2 to 4
- Rotational alignment feature on the RF disks
- Visual Inspection / Hand Deburbing of the RF disks (if needed)

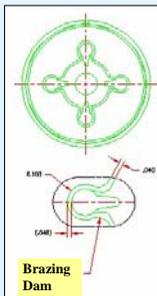


FXC-003 @NLCTA

Production History:

- FXC-001:** Completed on January 04. Disks were not hand deburred (brazing dam, keyhole radius). High frequency disks due to braze material leakage caused by burrs on the brazing dam. Did not perform well under high power testing.
- FXC-002:** Completed on January 04. All disks brazing dams were hand deburred except output coupler matching disk. High frequency output coupler matching disk due to braze material leakage cause by burrs on the brazing dam. No deburring around keyhole radius. Repaired with tuning pins brazing. Sent to SLAC for high power testing.
- FXC-003:** Completed on February 04. All disks brazing dams were hand deburred. Some disks were deburred around keyhole radius after inspection. Disks were etched twice. Achieved TRC R1 design requirement with 0.1 breakdowns in 1 hour with 65 MV/meter gradient. Currently undergoing high power testing.
- FXC-004:** Completed on March 04. All disks were hand deburred (brazing dam, keyhole radius). Disks were etched twice.
- FXC-005:** Completed on March 04. All disks were hand deburred (brazing dam, keyhole radius). Currently undergoing high power testing.

FXC-003

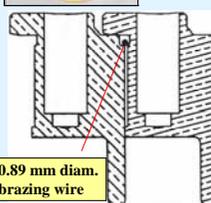


Brazing Dam



Dummy Disk

Brazing tests were conducted with dummy (no iris) disks



Rosette shape dam instead of circular dam to stop the braze material flow into the RF volume

0.89 mm diam. brazing wire

FXD Type RF Structures

- 60 cm. long, 61 mm o.d. cells; 150 degree phase advance; 4% group velocity; tapered design with slotted cells and .17 a/lambda
- Fully brazed construction w/o hydrogen
- FWG I/O couplers; I/O HOM extraction; twofold interleaving design feature (FXD-A and FXD-B)
- Keyhole radius burrs are eliminated on the RF disks by changing machining sequence
- We built one FXD structure for the 8-Pack test on March 04. This structure does not have any HOM extractions
- Subsequent 3 FXD structure will have output HOM extractions
- The rest of FXD structures will have input and output HOM extractions

High Power Test at SLAC

Results reported on June 23, 2004:

| Name | Built by | Gradient (MV/m) | Trip Rate (#/hr) |
|------------------------------|----------|-----------------|------------------|
| FXD1 A | FNAL | 65.4 | 0.18 |
| FXC5 | FNAL | 64.5 | 0.10 |
| H60vg 4S17-3 | KEK/SLAC | 65.4 | 0.04 |
| FXC3 | FNAL | 64.5 | 0.04 |
| FXB6 | FNAL | 64.8 | 0.00 |
| FXB7 | FNAL | 66.7 | 0.19 |
| H60vg 4S17-1 | KEK/SLAC | 63.2 | 0.10 |
| H60vg 3R17 | SLAC | 64.8 | 0.04 |
| Average | | 64.9 | 0.085 |
| Average One Month Ago | | 64.9 | 0.163 |